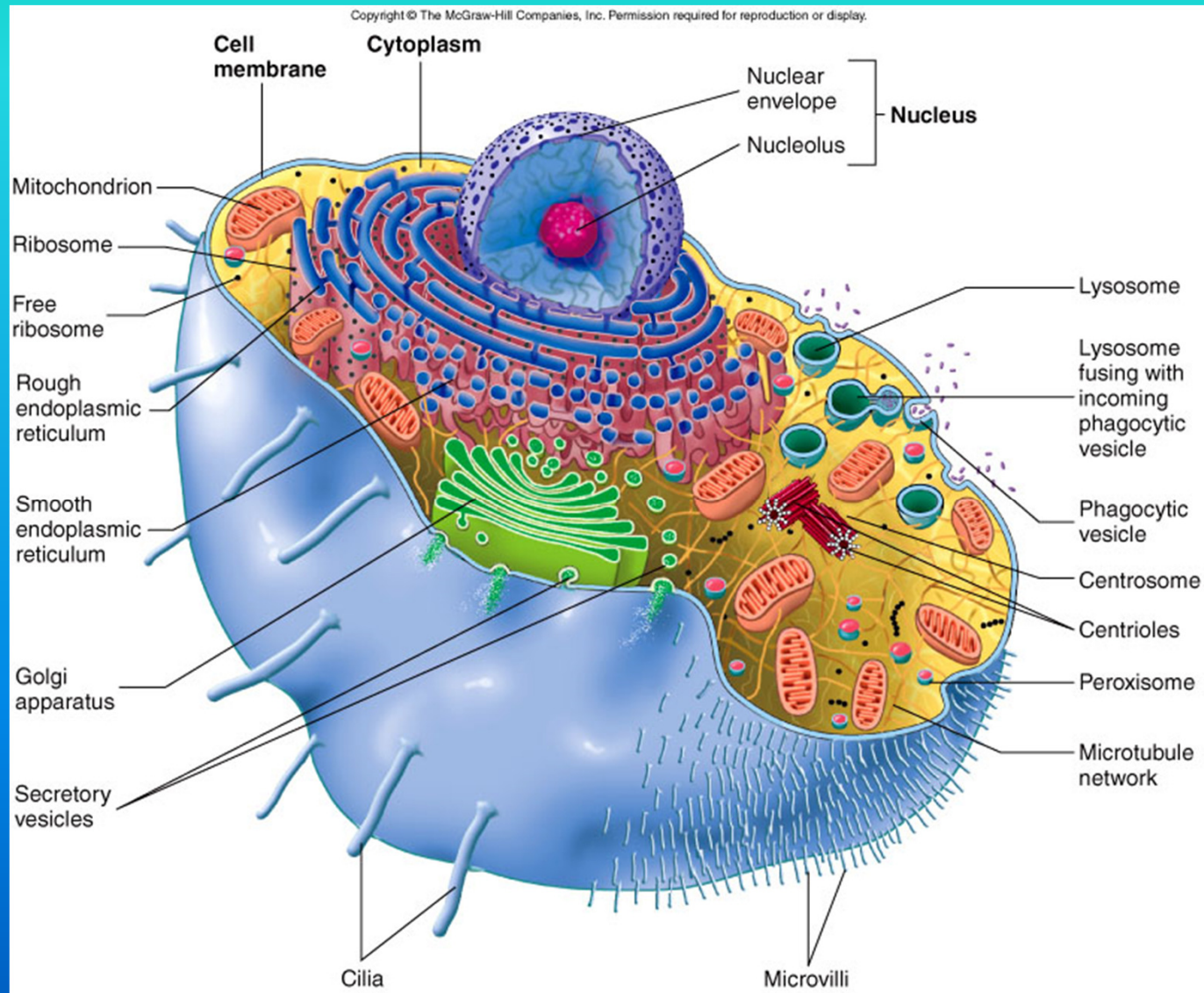


# CELLS

## Structure and Functions



- **Cell** = Basic organized unit of all living things
- In humans
  - Cells are organized into **tissues**
  - Tissues are organized into **organs**
  - Organs are organized into **organ systems**
- **Organelle** = specialized part of a cell performing one or more specific functions
  - Nucleus is the control center that contains genetic material
  - Cytoplasm is a jelly-like fluid that surrounds the nucleus and other organelles and is enclosed by the cell membrane

# Functions of the Cell

1. Basic unit of life
2. Protection and support
3. Movement
4. Communication
5. Cell metabolism and energy release
6. Inheritance

# Cell Membrane

- **Cell membrane** =
  - AKA *plasma membrane*
  - Outermost component of the cell
  - Is a selective barrier that determines what moves in and out of the cell
  - Plays a role in communication between cells

- **Fluid mosaic model**

- Double layer of phospholipids

- Polar, phosphate containing ends are hydrophilic

- Face the water inside and outside the cell

- Nonpolar, fatty acids ends are hydrophobic

- Face away from water, toward the center of the double layer

– Proteins

- Function as membrane channels, carrier molecules, receptor molecules, enzymes, or structural supports

– Cholesterol

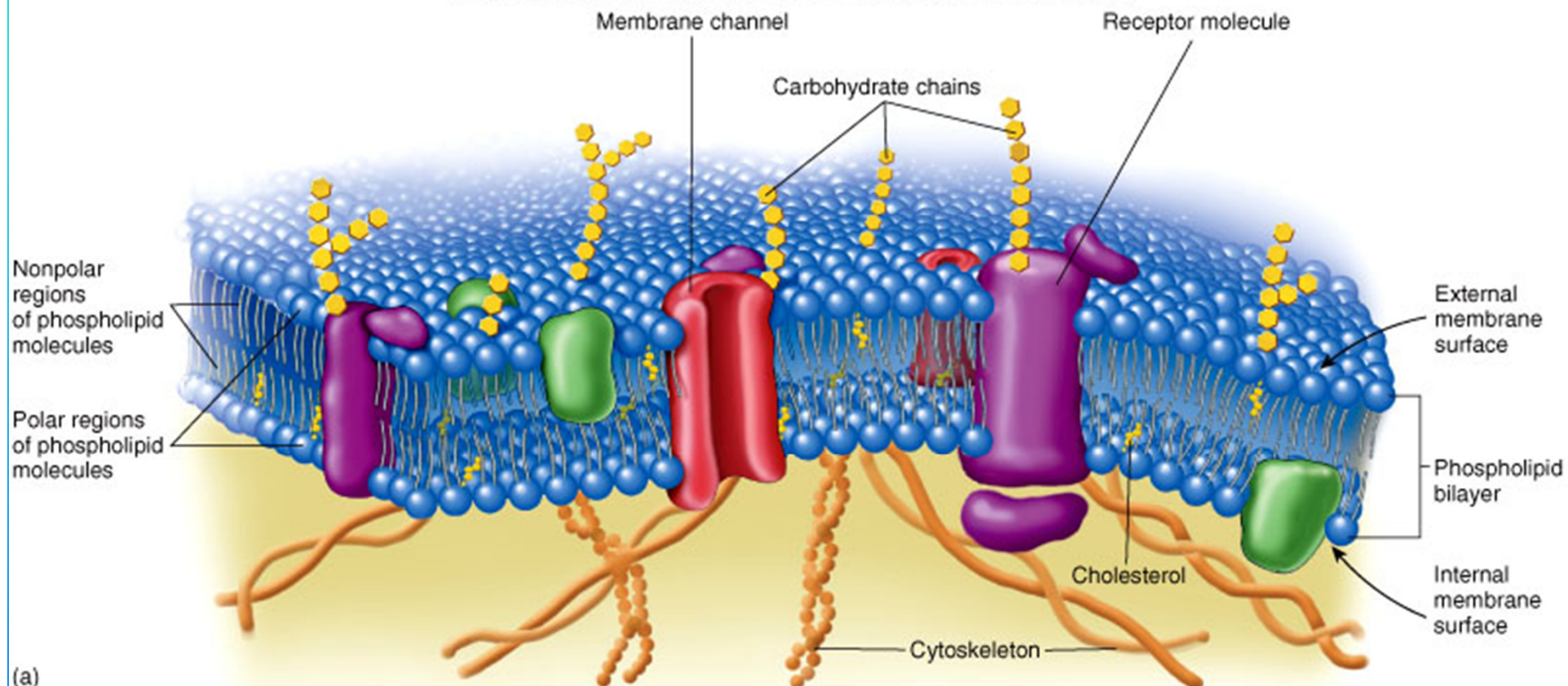
- Gives the membrane added strength and flexibility

– Carbohydrates

- Bound to some proteins, modifying their functions

– Water and ions

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- Cell membranes are **selectively permeable**
  - Allow some substances, but not others, to pass into or out of the cell
- Molecules pass through cell membranes in 4 ways
  1. Dissolving directly through the phospholipid membrane
    - Lipid soluble substances
      - $O_2$ ,  $CO_2$ , steroids
    - Certain small molecules
      - Water, urea

## 2. Membrane channels

- Allows small molecules and ions to pass through, according to their size, shape, and charge

## 3. Carrier molecules

- Transport large polar (non-lipid-soluble) molecules such as glucose and amino acids by binding to them

## 4. Vesicles

- Membrane-bound sacs that transport large non-lipid-soluble molecules, small pieces of matter, and even whole cells

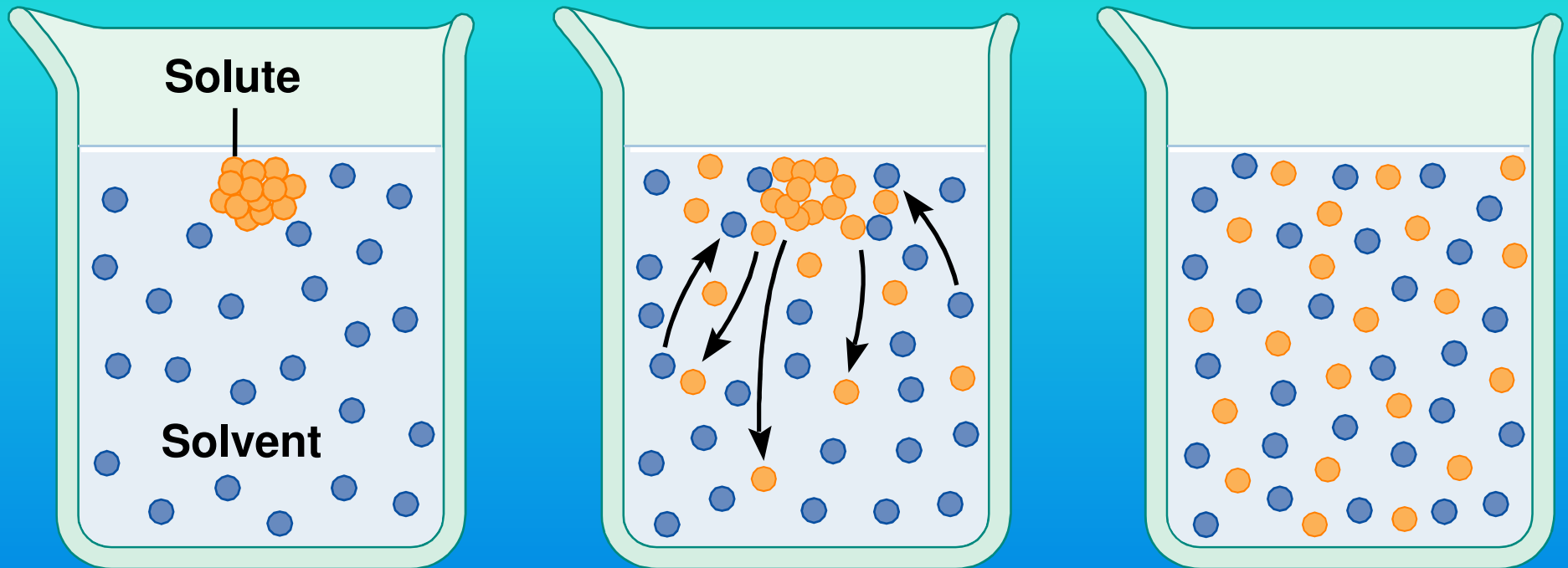
# Types of Movement Across Membranes

# Diffusion

- **Diffusion** =
  - Tendency for solutes to move from an area of higher concentration to an area of lower concentration
- At **equilibrium** the NET movement of solutes stops, although the random motion continues

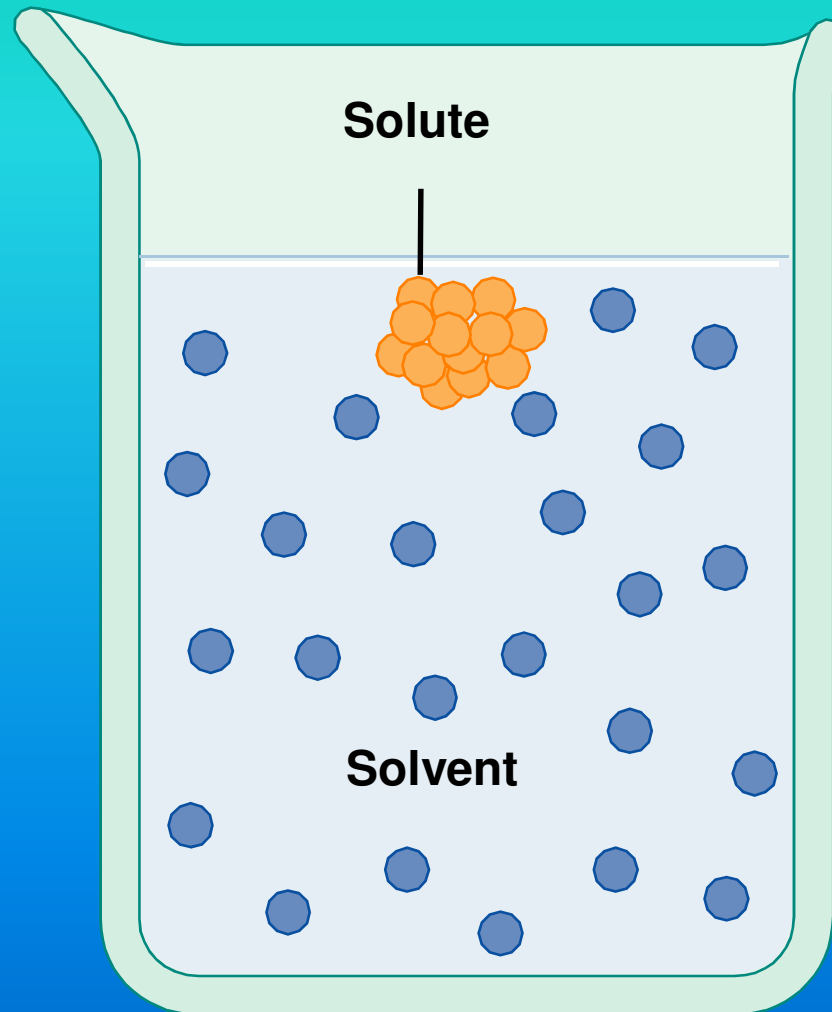
# Diffusion

Slide number: 1



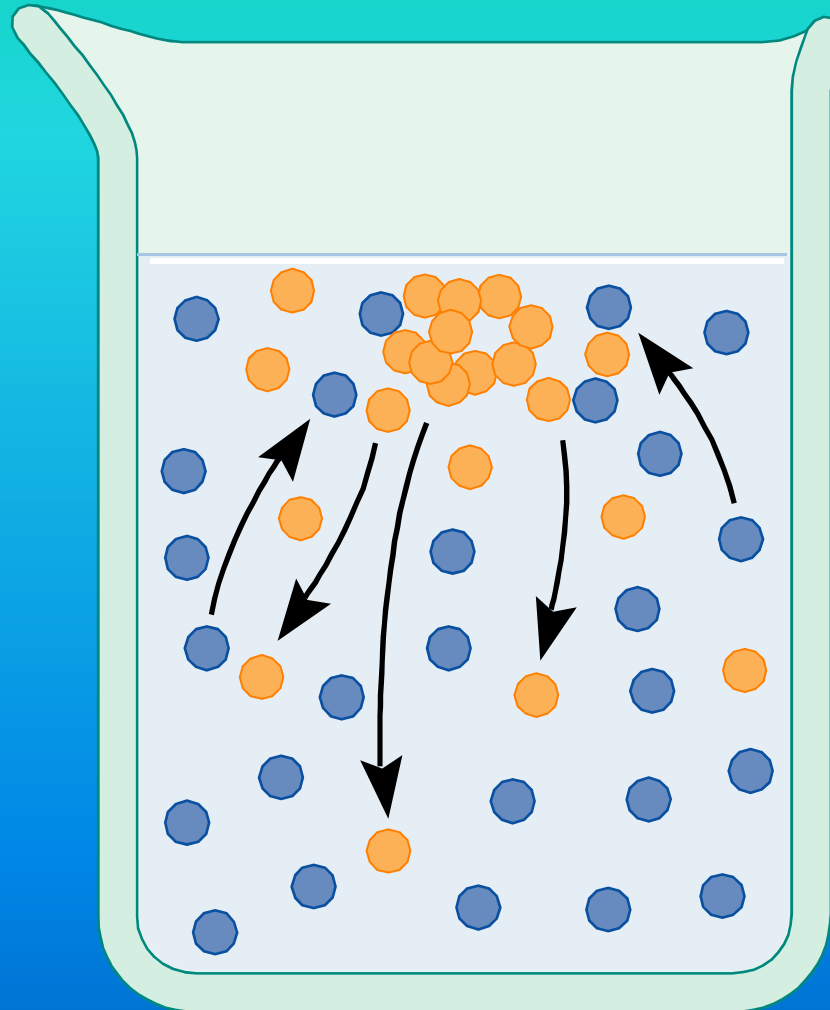
# Diffusion

Slide number: 2



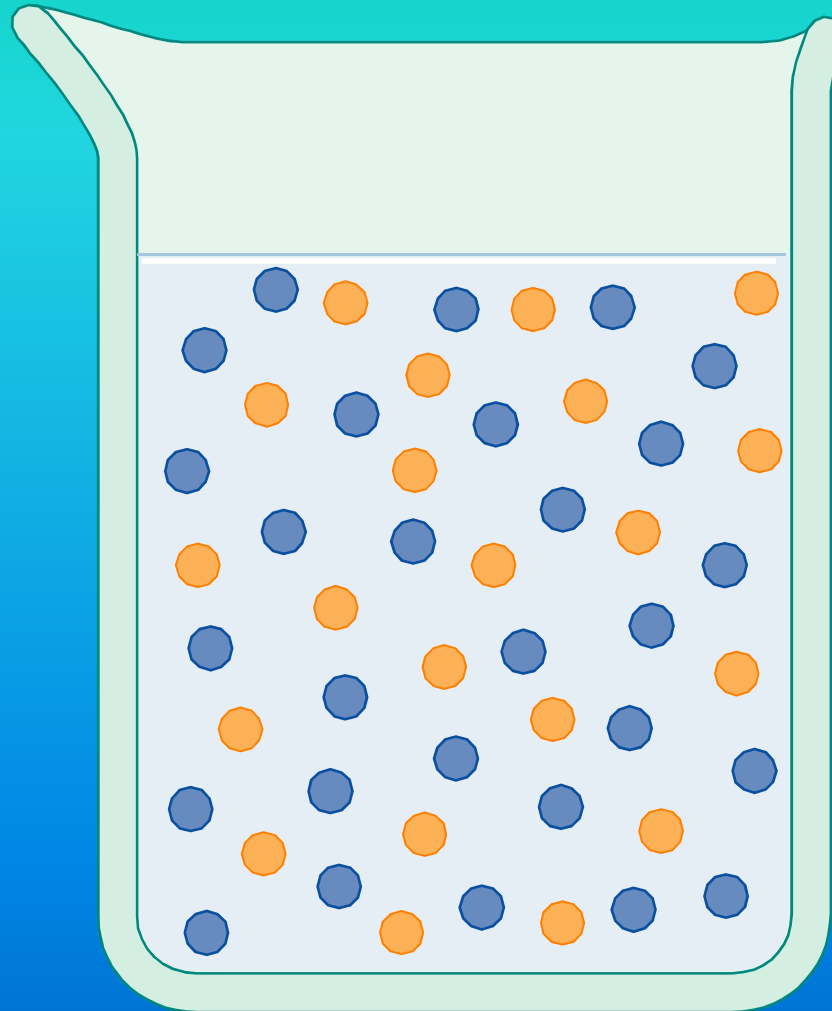
# Diffusion

Slide number: 3



# Diffusion

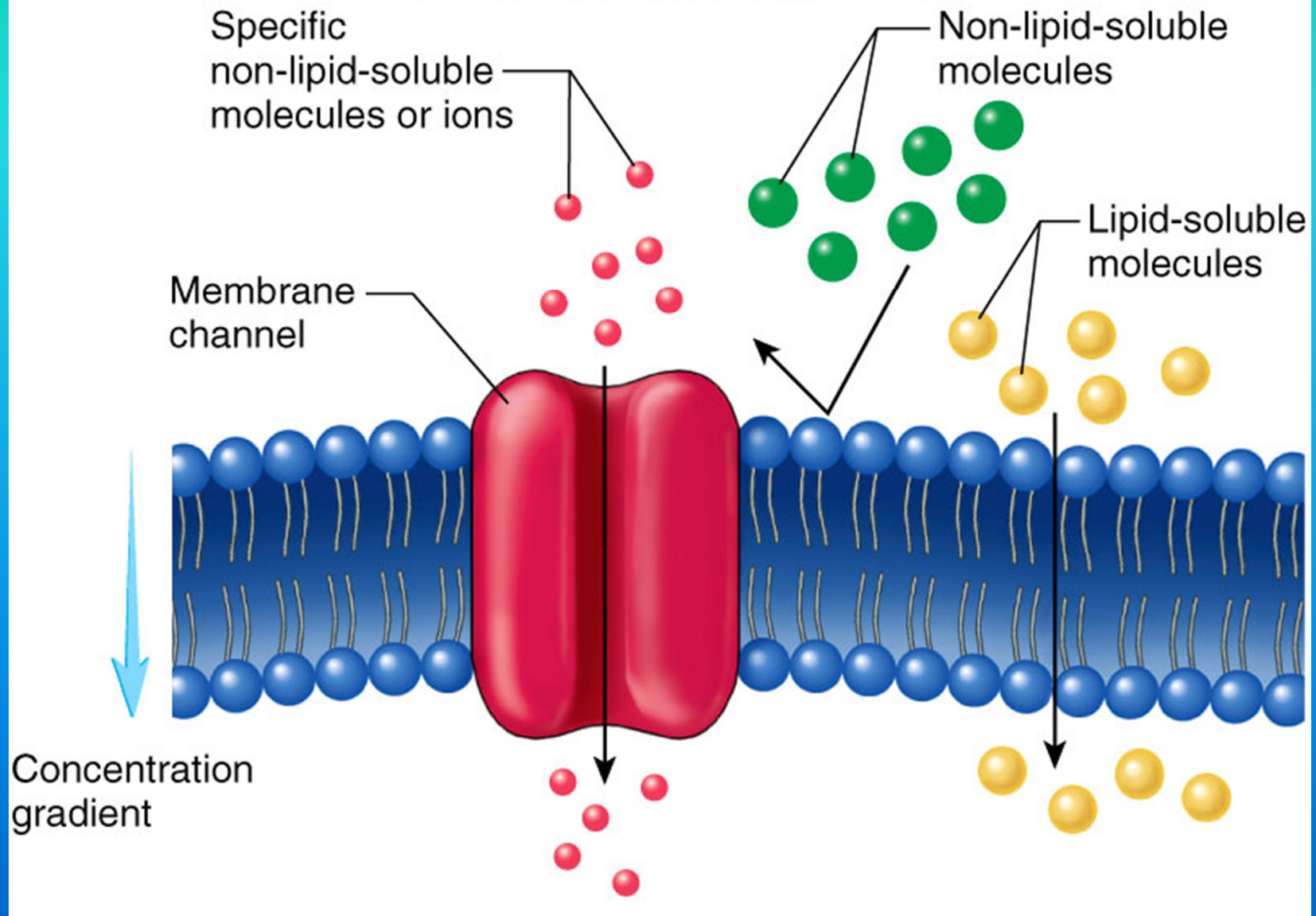
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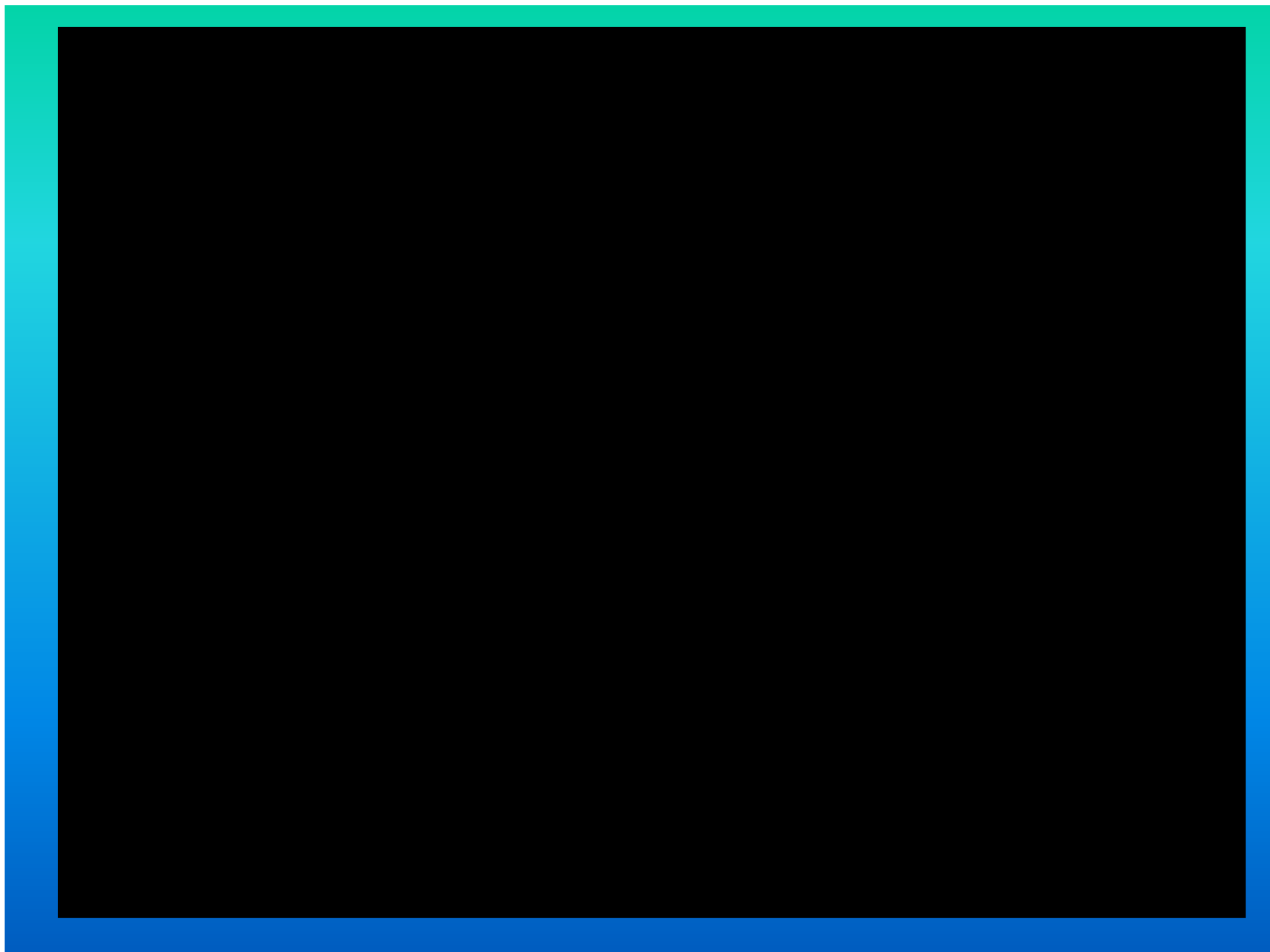




- **Concentration gradient** =
  - Measure of the difference in the concentration of a solute in a solvent between 2 points divided by the distance between the 2 points
  - Steeper when either or both
    - Concentration difference between the 2 points is large
    - The distance is small
- Diffusion occurs down, or with, the concentration gradient
  - Lipid-soluble molecules diffuse directly through the cell membrane
  - Non-lipid soluble molecules diffuse through membrane channels

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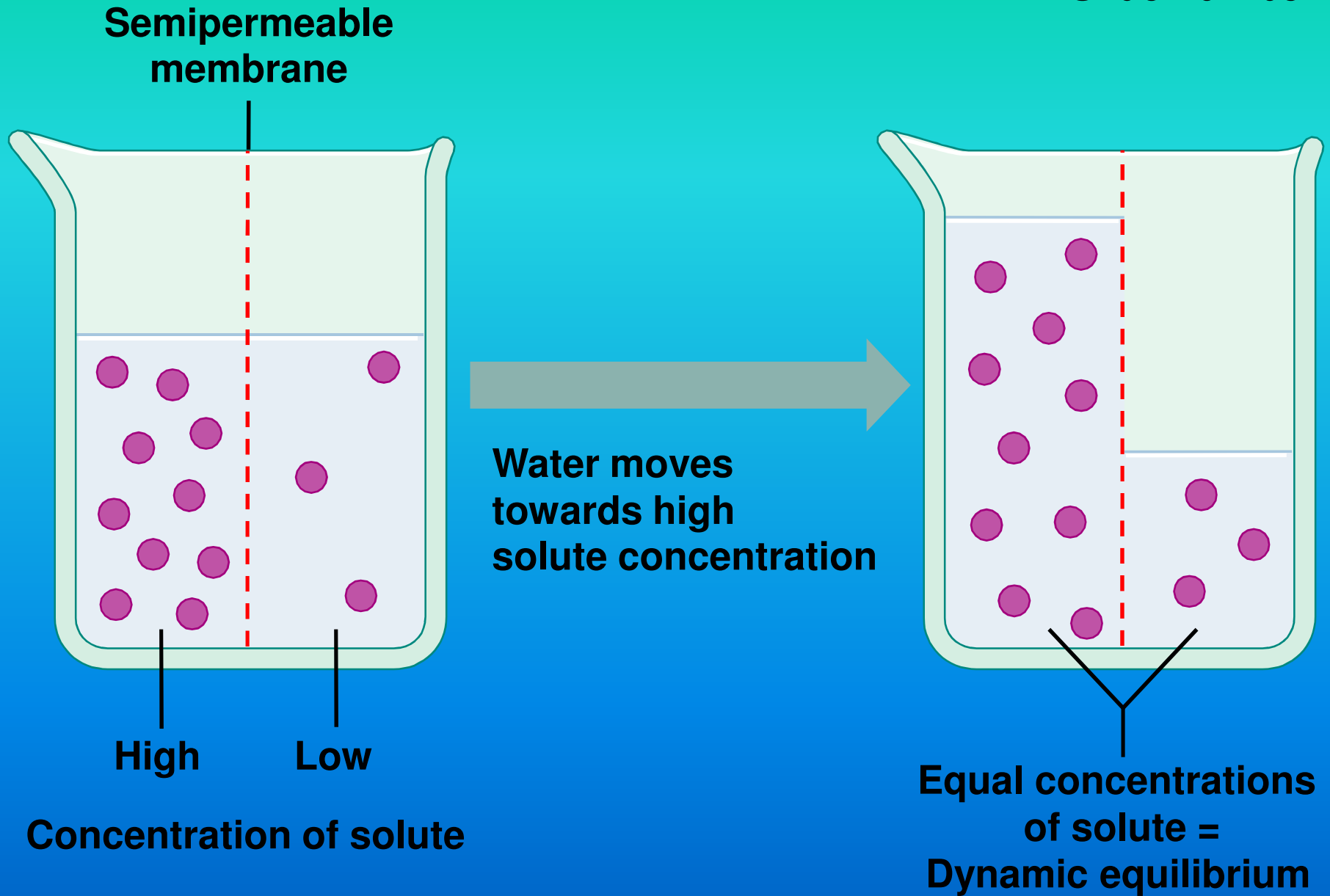
# Osmosis

- **Osmosis** =
  - The diffusion of water across a selectively permeable membrane from a region of higher water concentration to one of lower water concentration
- **Osmotic pressure** =
  - Force required to prevent the movement of water across a selectively permeable membrane
  - A measure of the tendency of water to move by osmosis across a selectively permeable membrane

- Water moves
  - From less concentrated solutions
    - less solute, more water
  - Into more concentrated solutions
    - more solute, less water
- The greater the concentration of a solution
  - The greater the tendency for water to move into the solution
  - The greater the osmotic pressure must be to prevent that movement

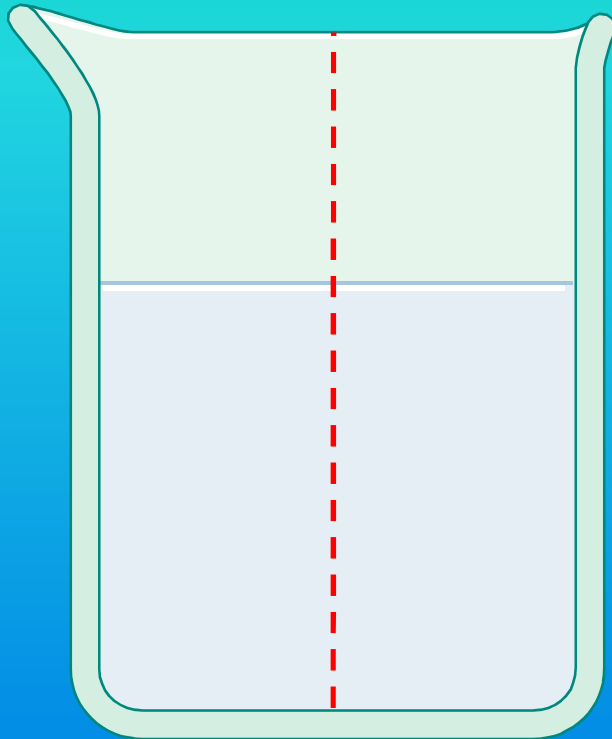
# Osmosis

Slide number: 1



# Osmosis

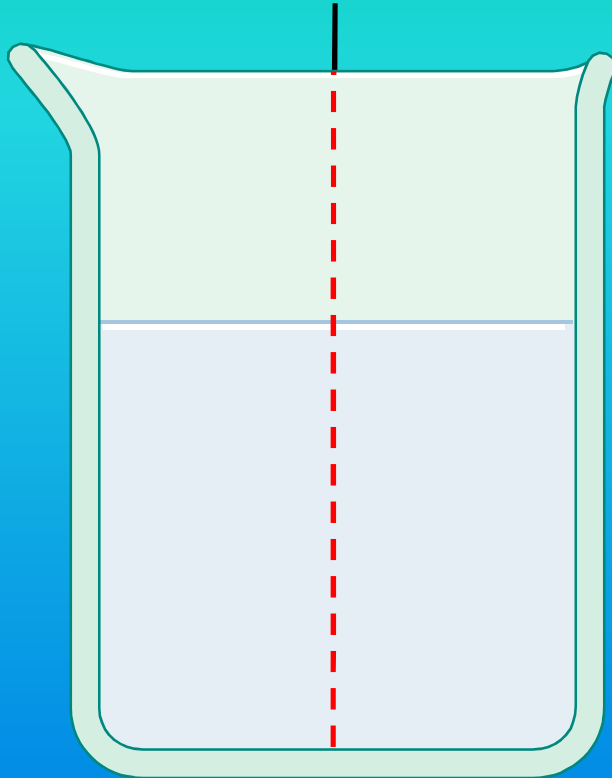
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# Osmosis

Slide number: 3

Semipermeable  
membrane

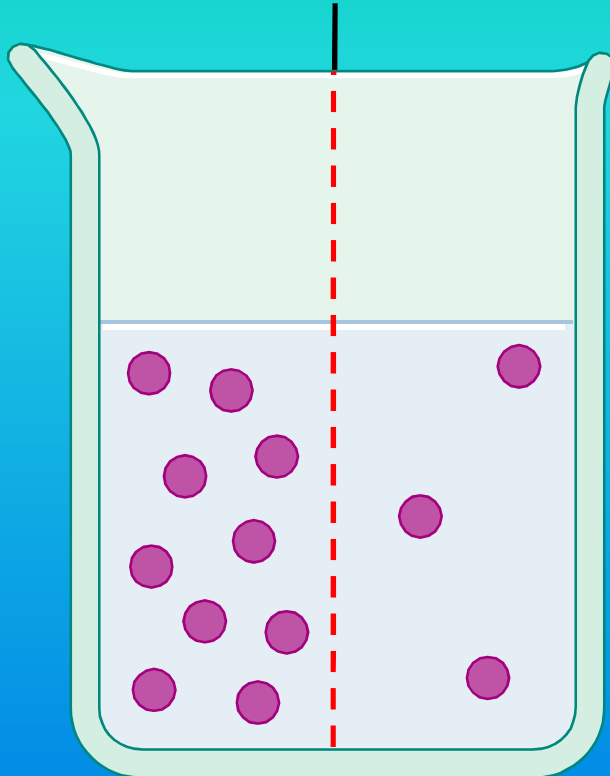




# Osmosis

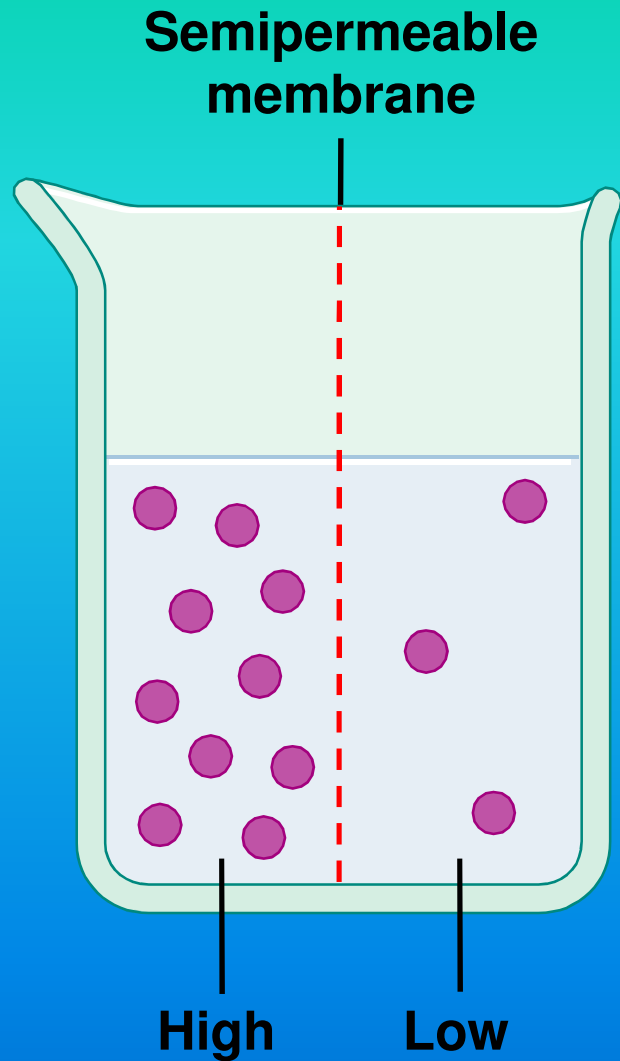
Slide number: 4

Semipermeable  
membrane



# Osmosis

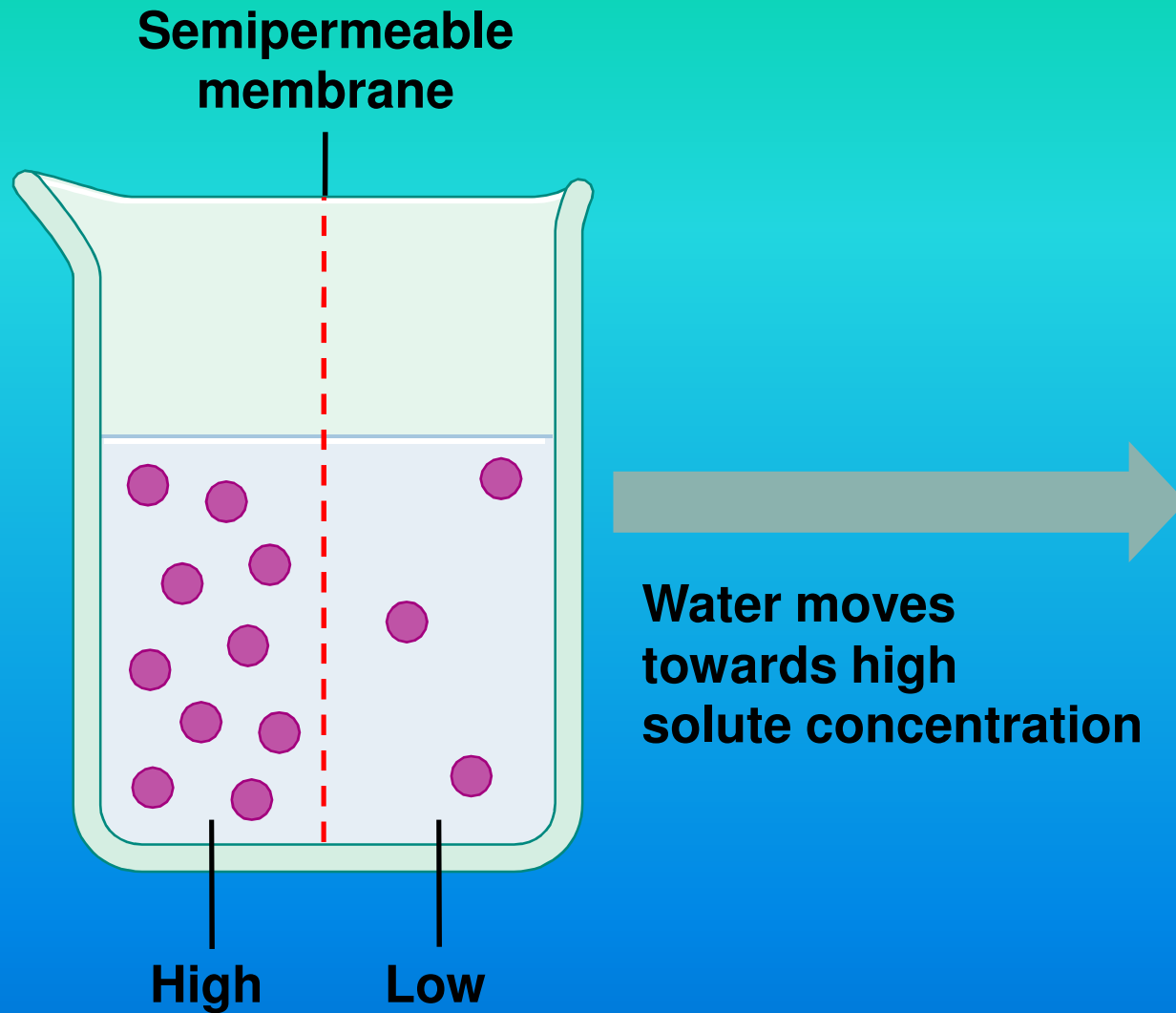
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Concentration of solute

# Osmosis

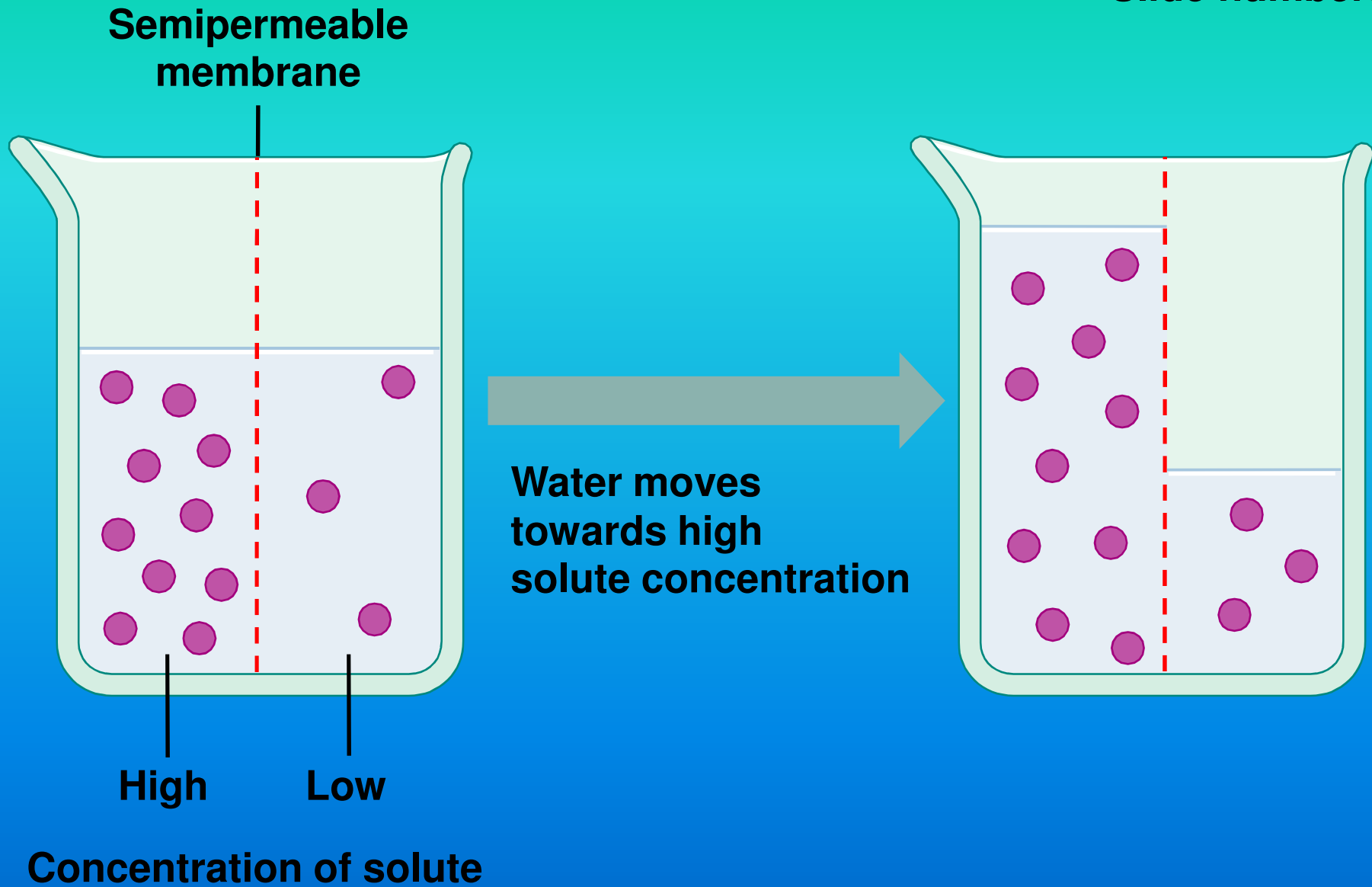
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Concentration of solute

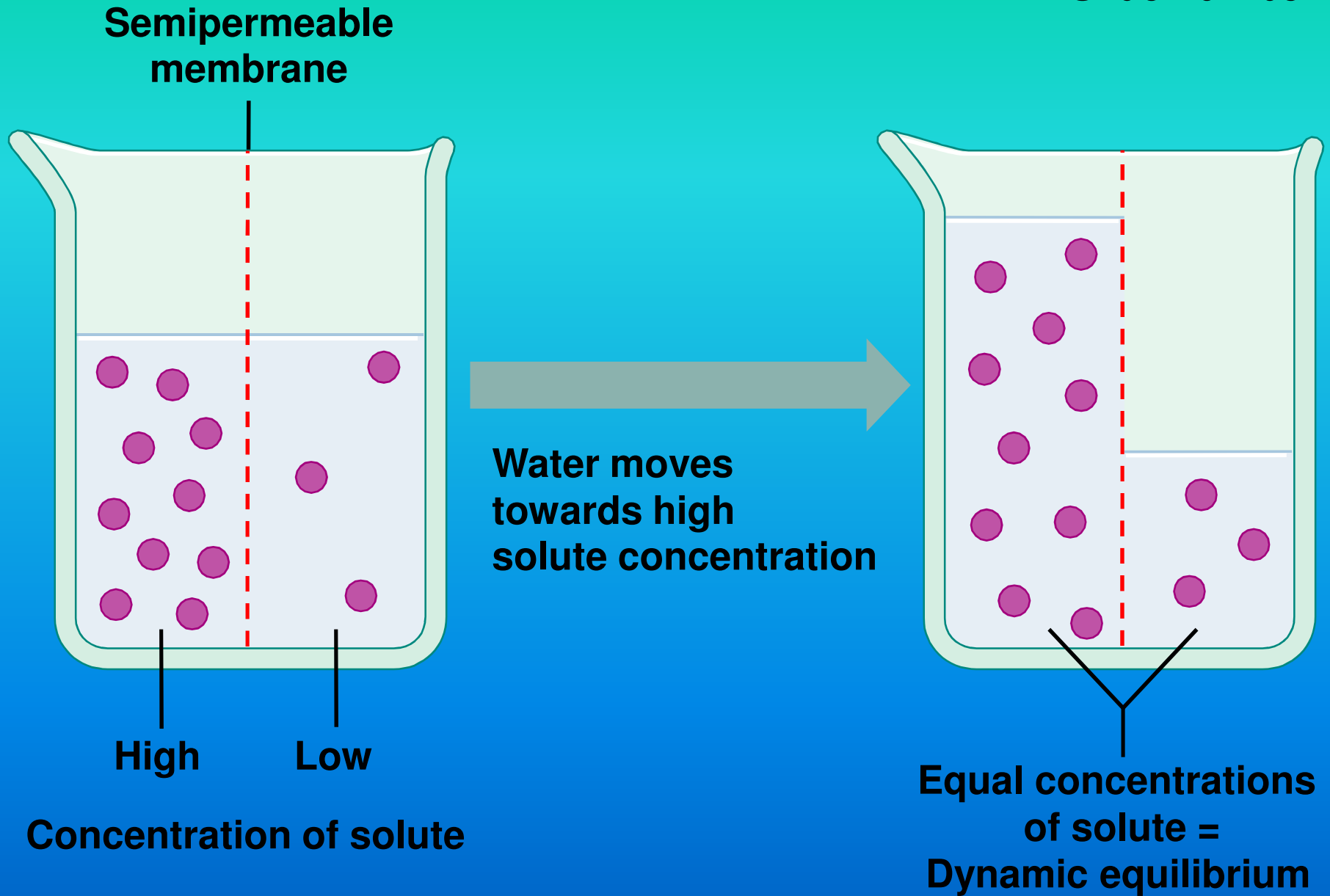
# Osmosis

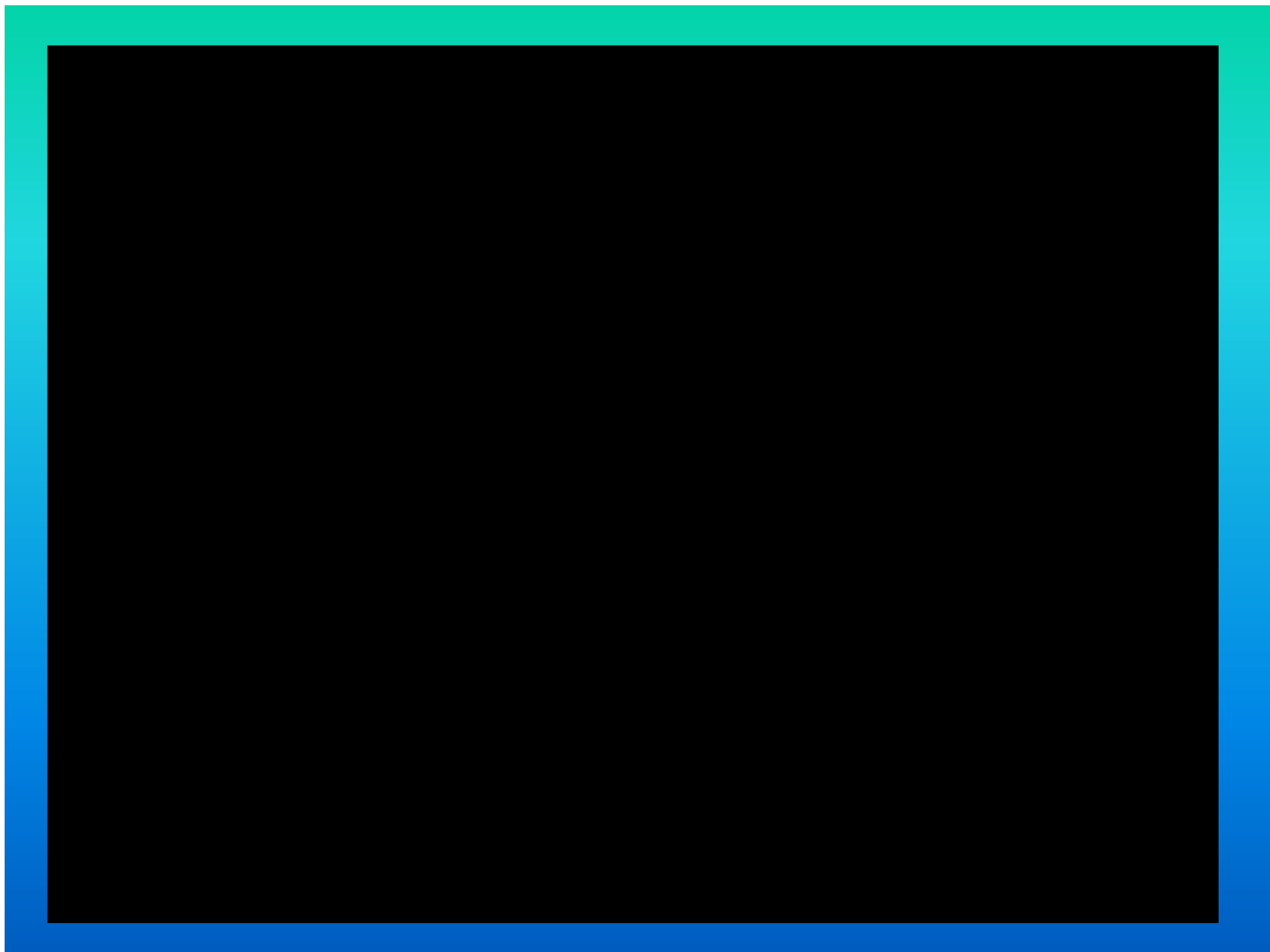
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# Osmosis

Slide number: 8





- **Hypotonic solution**=

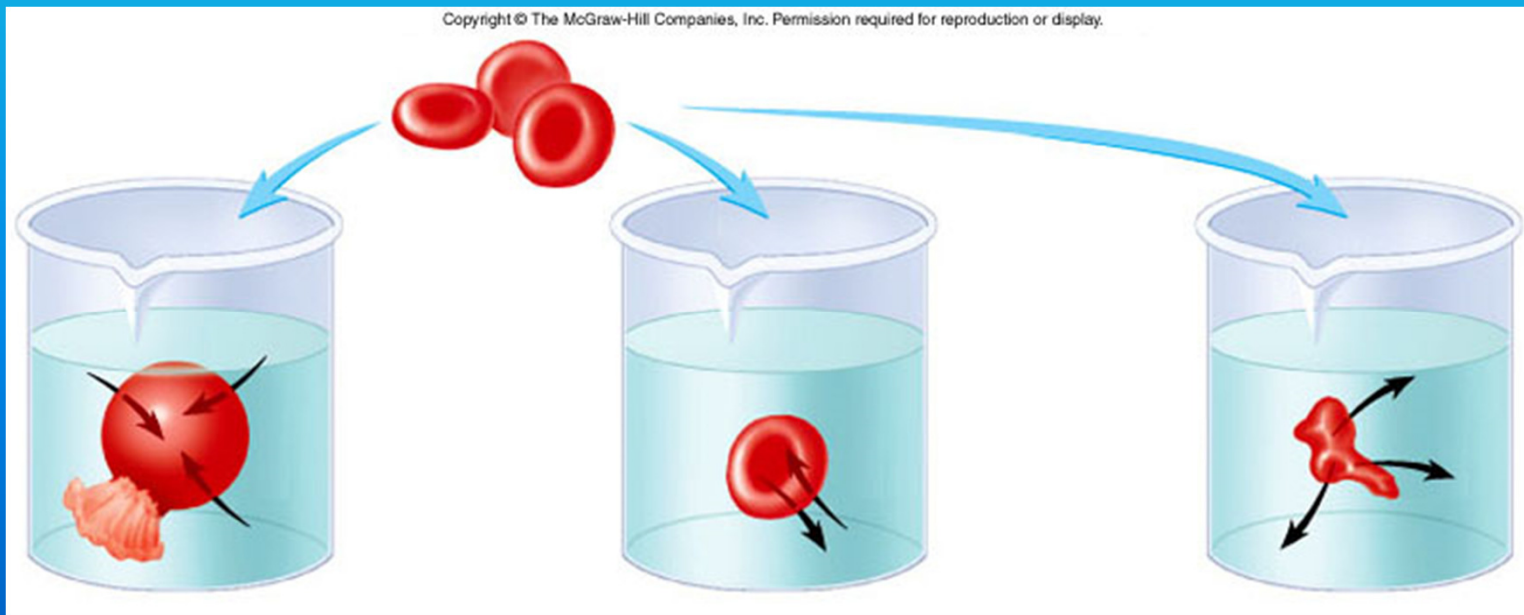
- Lower concentration of solutes and a higher concentration of water outside the cell
- Water moves into the cell
- **Lysis** = cell ruptures

- **Isotonic solution**=

- Concentrations of solutes and water are the same on both sides of the cell membrane
- Cells neither swell nor shrink

- **Hypertonic solution**=

- Higher concentration of solutes and a lower concentration of water outside the cell
- Water moves out of the cell
- **Crenation** = cell shrinks





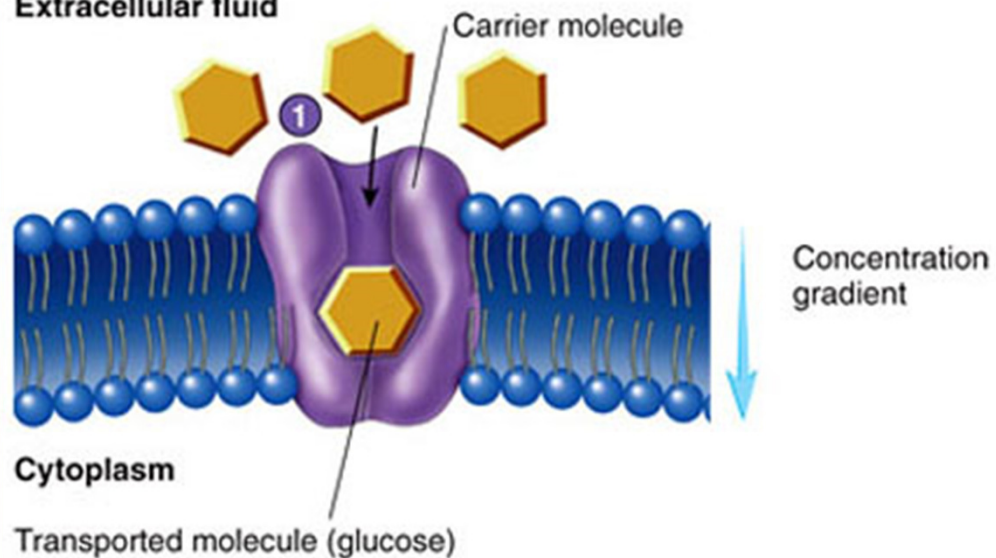
# Filtration

- **Filtration** =
  - Movement of a fluid through a partition containing small holes
    - The fluid and substances small enough to pass through the holes move through
    - Substances larger than the holes do not
  - Results from a pressure difference

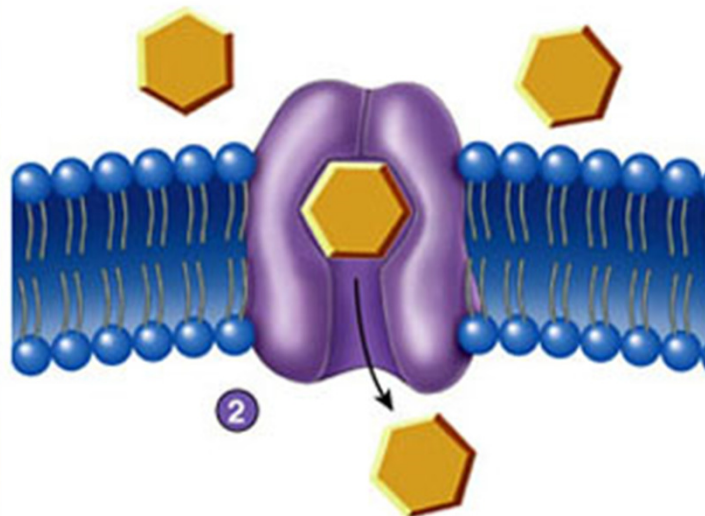
# Mediated Transport Mechanisms

- **Carrier-mediated transport mechanisms** =
  - Move large, water-soluble molecules or electrically charged ions across the cell membrane
  - Only **specific** molecules can be transported by each carrier
  - **Facilitated diffusion** =
    - Moves substances into or out of cells from a higher to a lower concentration of that substance
    - IE - movement is WITH the concentration gradient
    - No ATP required

**Extracellular fluid**



1. The carrier molecule binds with a molecule, such as glucose, on the outside of the cell membrane.



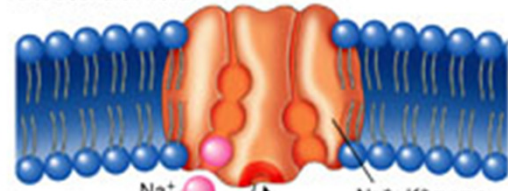
2. The carrier molecule changes shape and releases the molecule on the inside of the cell membrane.

– **Active transport** =

- Moves substances across the cell membrane from lower to higher concentrations of that substance
- IE - movement is AGAINST the concentration gradient
- Requires energy in the form of ATP
- Example: **Sodium-potassium pump** =
  - Moves  $\text{Na}^+$  out of cells
  - Moves  $\text{K}^+$  into cells
  - Results in higher concentration of  $\text{Na}^+$  outside and higher concentration of  $\text{K}^+$  inside

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Extracellular fluid



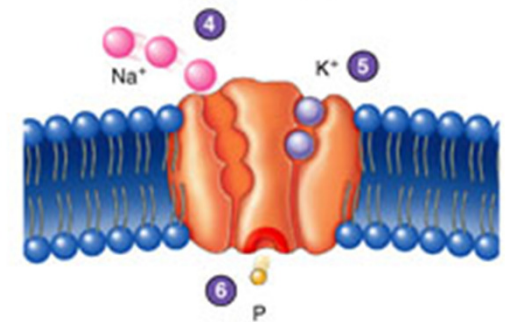
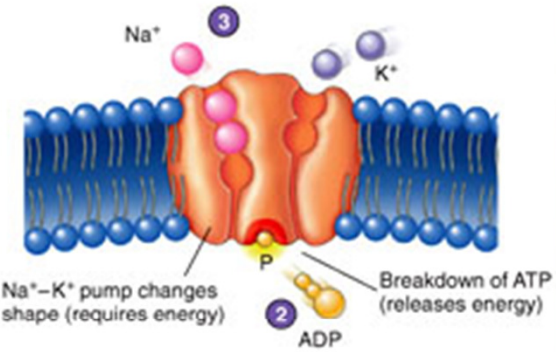
Cytoplasm

1

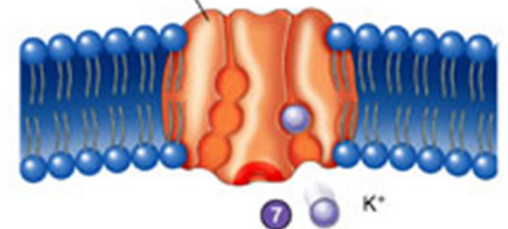
Na<sup>+</sup>

ATP binding site on Na<sup>+</sup>-K<sup>+</sup> pump

ATP



Na<sup>+</sup>-K<sup>+</sup> pump resumes original shape





– **Secondary active transport** =

- Involves active transport of one substance across a cell membrane, establishing a concentration gradient, providing energy to transport a second substance
- **Cotransport** =
  - Diffusing substance moves in the SAME direction as the transported substance
- **Countertransport** =
  - Diffusing substance moves in the OPPOSITE direction as the transported substance

**Extracellular fluid**  
(outside)

$\text{Na}^+ - \text{K}^+$   
pump

$\text{Na}^+$

1

$\text{K}^+$

**Cytoplasm**  
(inside)

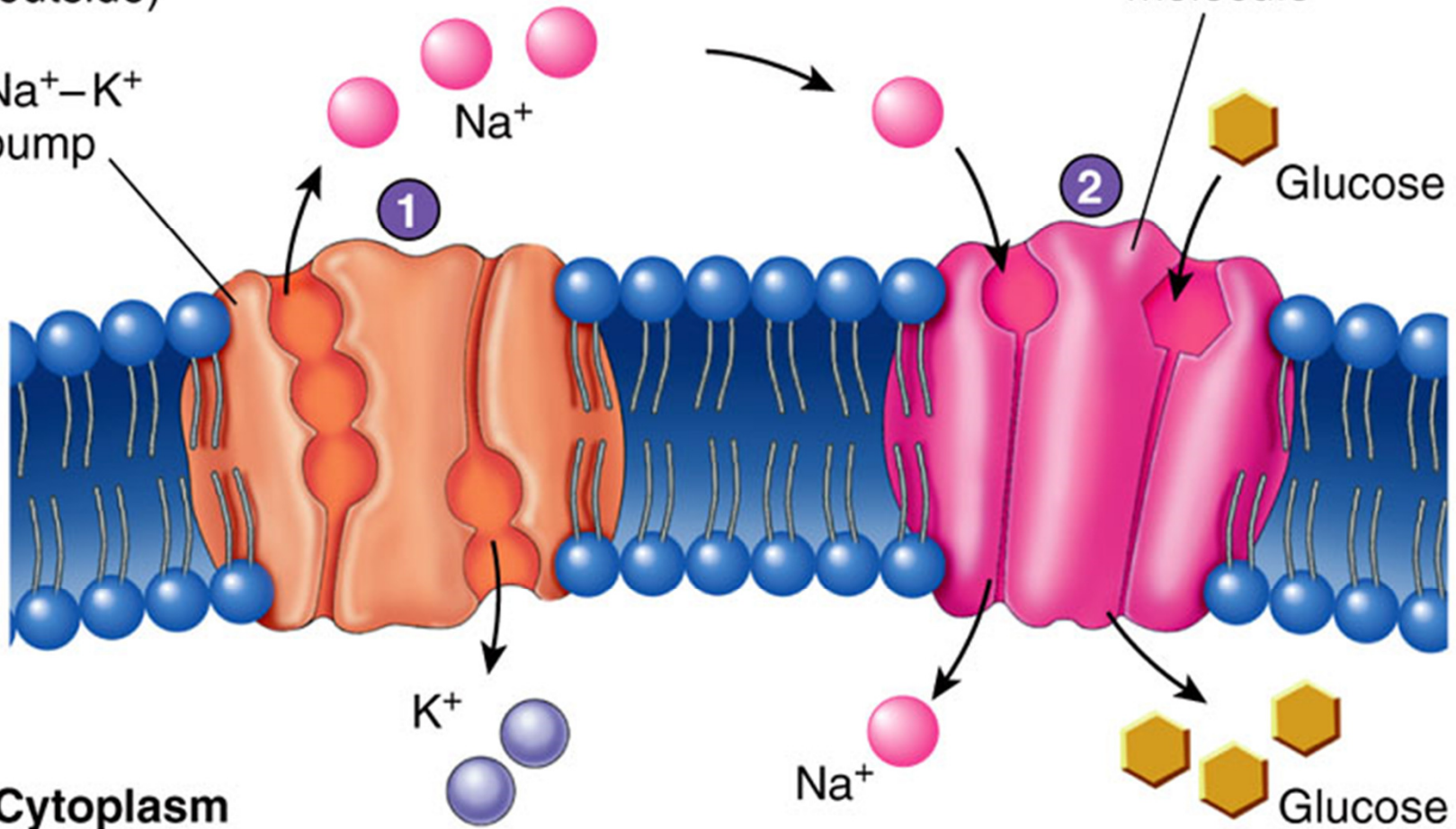
$\text{Na}^+$

Carrier  
molecule

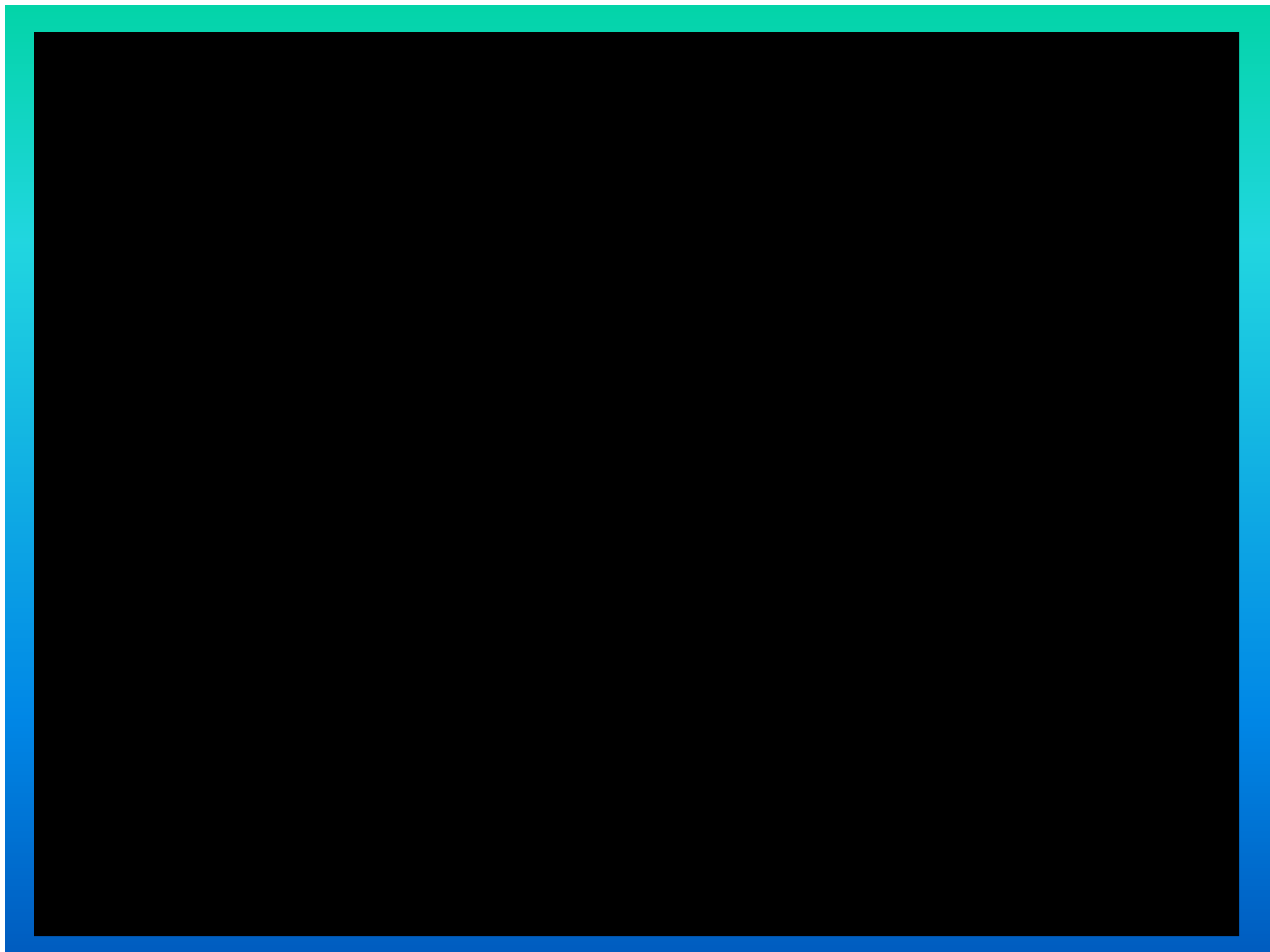
Glucose

2

Glucose

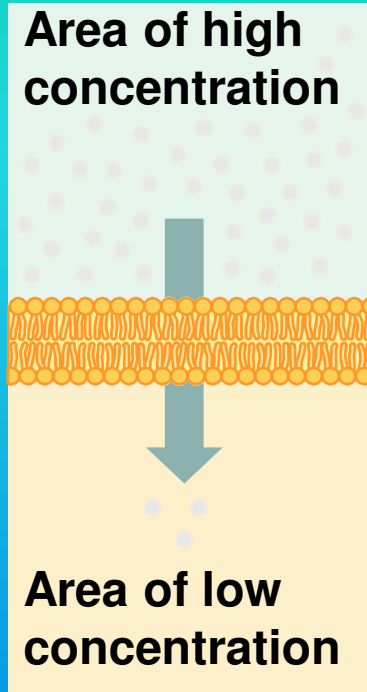




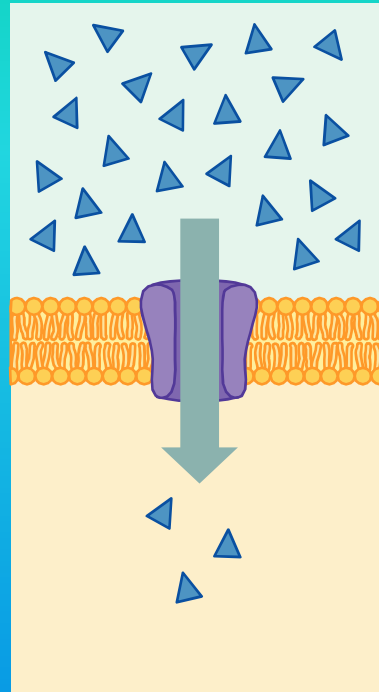


# Transport Moves Substances

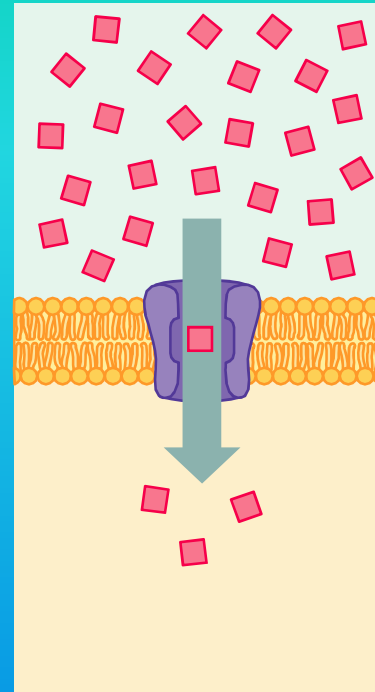
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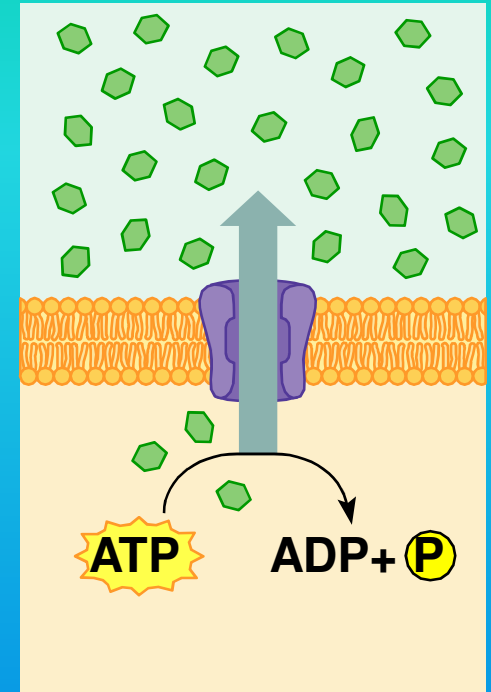
**A** Simple diffusion



**B** Facilitated diffusion—channel



**C** Facilitated diffusion—carrier



**D**

**Passive transport**  
**No energy required**

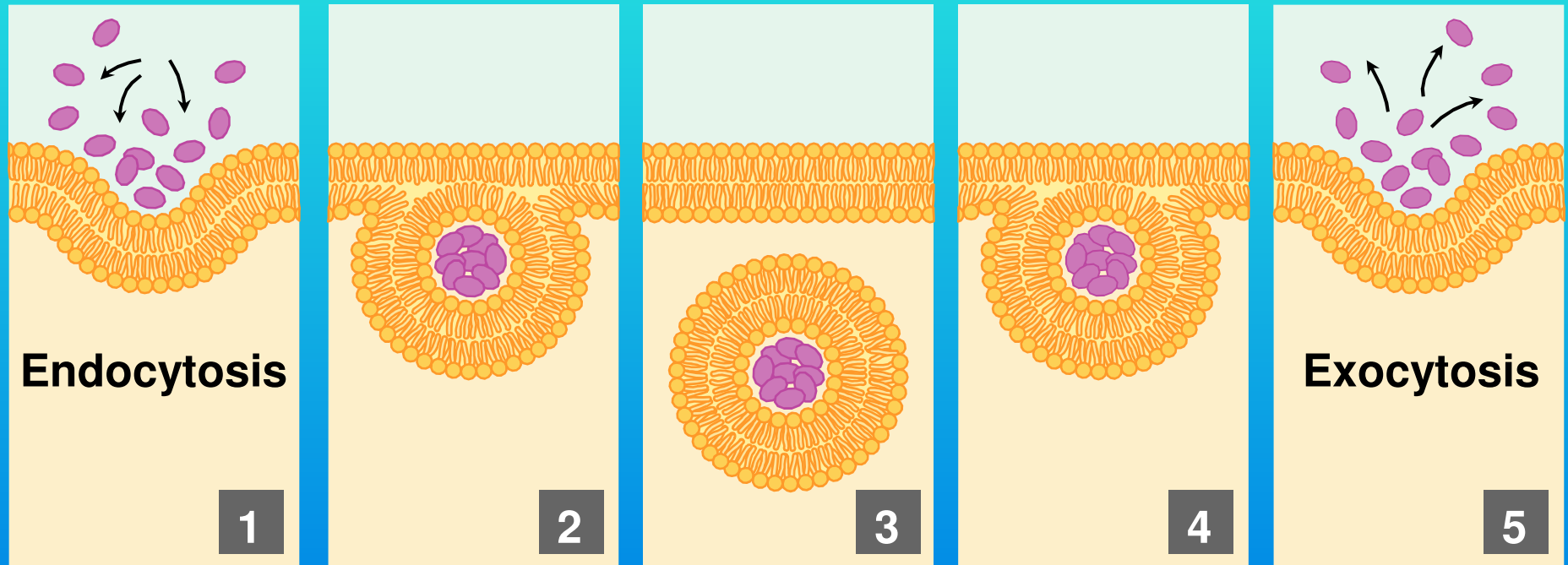
**Active transport**  
**Energy required**

# Endocytosis and Exocytosis

- **Endocytosis** =
  - Uptake of material through the cell membrane by the formation of a membrane-bound sac called a vesicle
  - **Phagocytosis** =
    - Movement of solid materials into cells
  - **Pinocytosis** =
    - Materials moved into cell are smaller and in solution
- **Exocytosis** =
  - Elimination of material from a cell through the formation of vesicles

# Endocytosis and Exocytosis

Slide number: 1

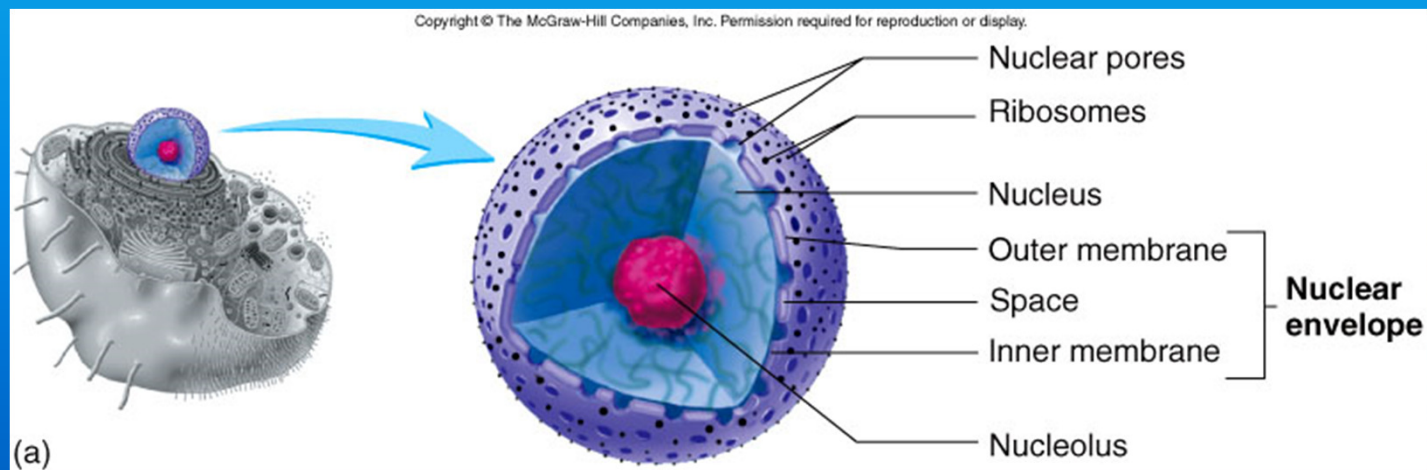


# Organelles

# **Nucleus**

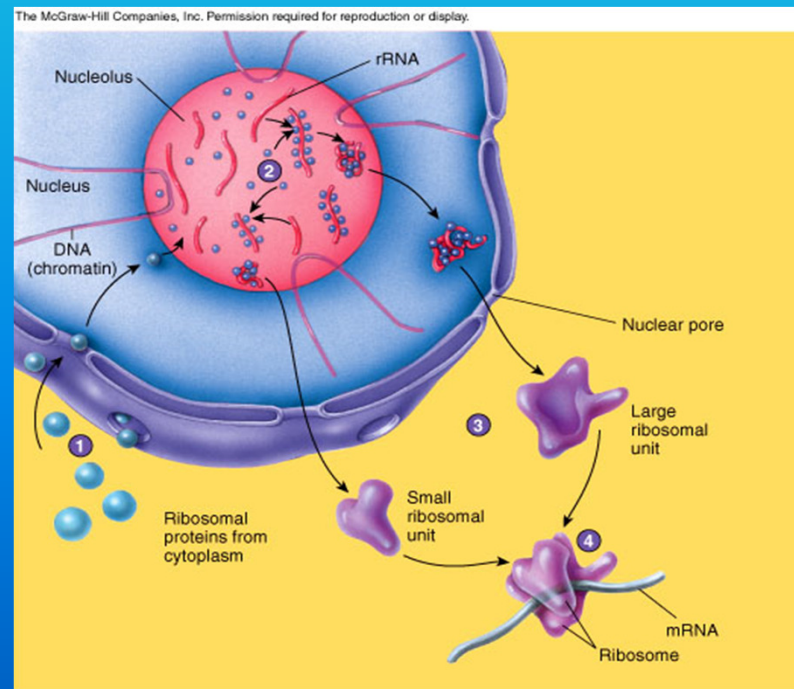
- Control center of the cell usually located near the center
- Contains most of the genetic information of the cell
- Surrounded by a **nuclear envelope** =
  - Controls what moves into and out of nucleus
- Contains **nucleolus** =
  - Subunits of ribosomes are manufactured here

- Nucleus also contains **chromatin** =
  - Loosely coiled fibers consisting of DNA and proteins
  - During cell division, chromatin fibers become more tightly coiled to form **chromosomes**
- Humans have 23 pairs of chromosomes



# *Ribosomes*

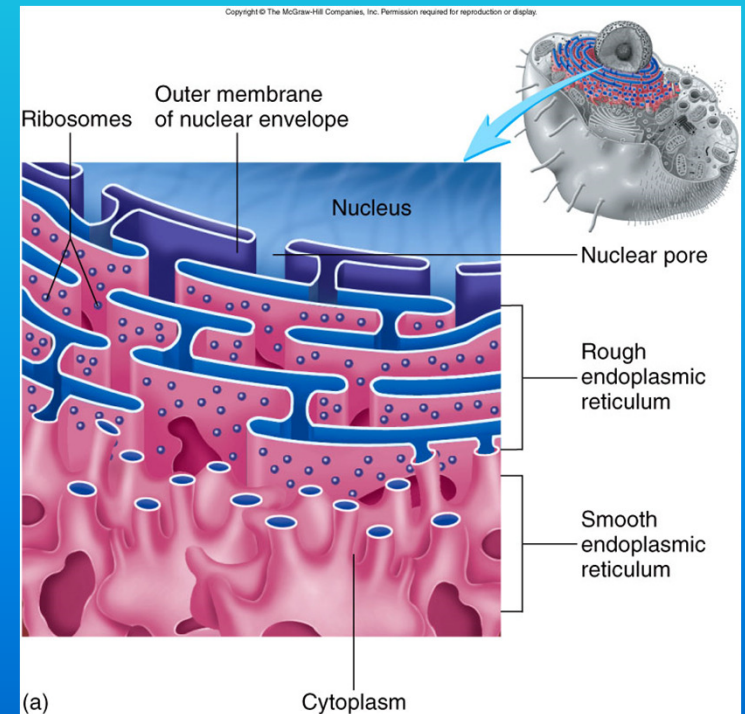
- Proteins are produced here
- Some are attached to rough endoplasmic reticulum
- Others are free in the cytoplasm





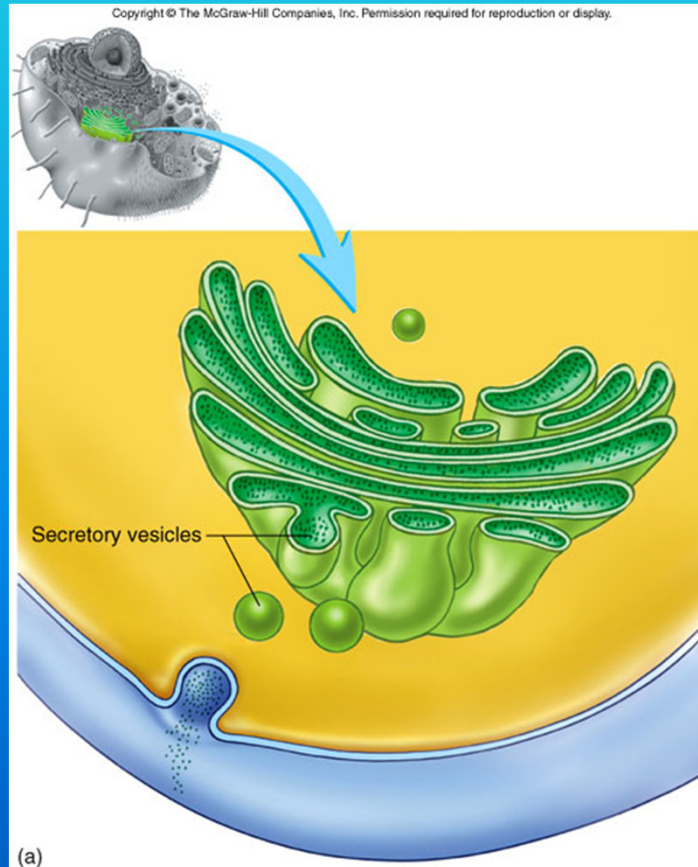
# ***Rough and Smooth Endoplasmic Reticulum (ER)***

- Channels that extend from the outer nuclear membrane into the cytoplasm to transport materials within the cell
- Rough er has ribosomes attached to it
  - Site for protein exportation
- Smooth er does not have ribosomes
  - Site for lipid synthesis and detoxification of chemicals within cells



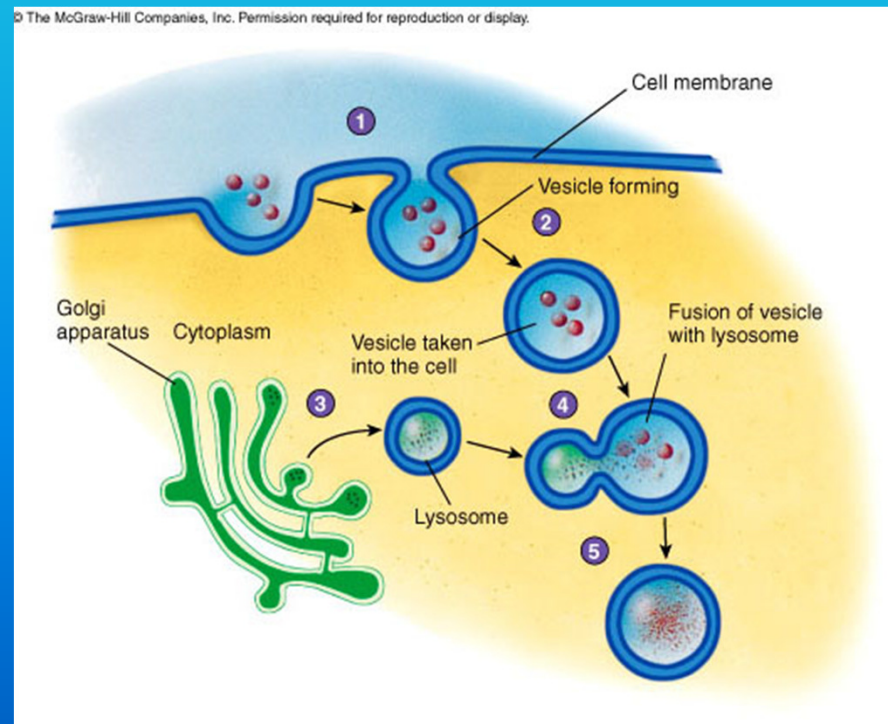
# *Golgi Apparatus*

- Collects, modifies, packages, and distributes proteins and lipids manufactured by the ER



# *Secretory Vesicles*

- Small, membrane-bound sacs that transport or store materials within cells
- Pinch off from golgi apparatus and move to the surface of the cell



# **Lysosomes and Peroxisomes**

- **Lysosomes** =

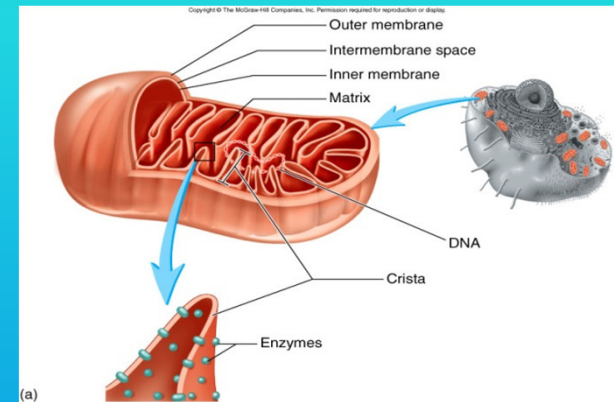
- Vesicles containing digestive enzymes to clean up the cell

- **Peroxisomes** =

- Vesicles containing enzymes that break down fatty acids, amino acids, and hydrogen peroxide

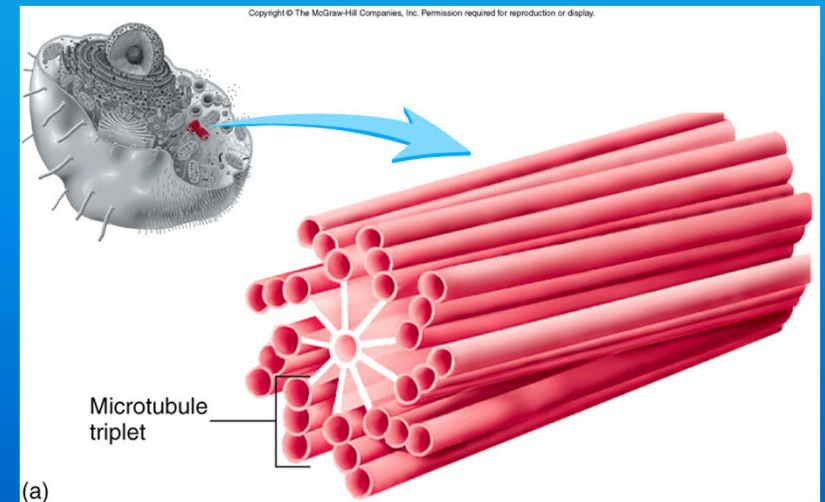
# Mitochondria

- Major sites of ATP production, which cells use as an energy source
  - Carry out aerobic respiration
- **Cristae** =
  - Numerous folds of the inner membrane of mitochondria
  - This increased surface area allows for more ATP production
- Contain their own unique type of DNA



# Centrioles

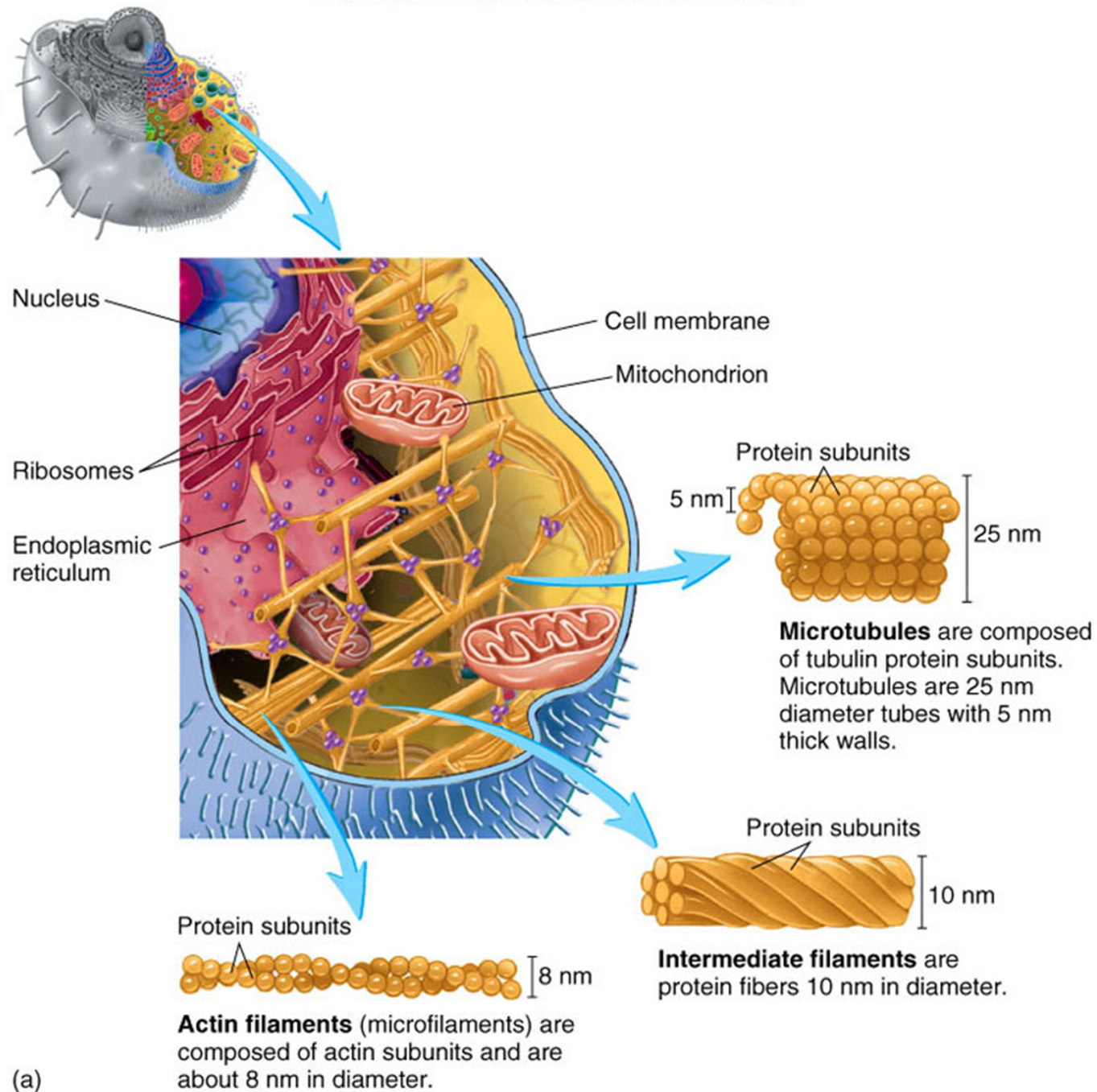
- Facilitate movement of chromosomes during cell division
- Centrosome =
  - Specialized zone of cytoplasm close to the nucleus which is the center of microtubule formation
  - Contains 2 centrioles



# **Cytoskeleton**

- Consists of proteins that support the cell, hold organelles in place, and enable the cell to change shape
- Consists of
  - **Microtubules** =
    - Assist in cell division
    - Form components of cilia and flagella
  - **Microfilaments** =
    - Some are involved with cell movements
  - **Intermediate filaments** =
    - Smaller in diameter than microtubules but larger than microfilaments







# ***Cilia, Flagella, Microvilli***

- ***Cilia*** =
  - Hair-like structures that move substances over the surface of cells
- ***Flagellum*** =
  - Whip-like structure (much longer than cilia) that propels sperm cells
- ***Microvilli*** =
  - Increase surface area of cells and aid in absorption
  - Do not actively move